Sharing Insights on Invasive Phragmites Management

Introduction

Abundant information on managing invasive *Phragmites* is available, including a well-crafted third edition to the Michigan Departments of Environmental Quality *Phragmites* Control manual (MDEQ 2014) and access to current, relevant research via the Great Lakes *Phragmites* Collaborative (GLPC). However, invasive *Phragmites* management in the U.S. continues to be criticized for lacking quantitative monitoring data that are routinely made public, in spite of the millions of dollars that are spent controlling this species every year (Blossey 1999, Martin et al. 2013, Hazelton et al. 2014, Quirion et al. 2017). Indeed, few grant sources require and fund more than minimal, short-term monitoring activities. Direct discussions with many resource managers indicate that although they believe their management results are generally good, when pressed for details, they often do not have hard data to back up their assertions, or their data is limited, e.g., qualitative or quantitative changes in percent cover or density of invasive *Phragmites*, but no other important ecosystem or landscape level measures, and sometimes their assertions are simply gut level declarations. There are some clear exceptions to this.

It was this concern that prompted one objective of our *Implementing Adaptive Management and Monitoring for Restoration of Invasive Phragmites* project: to compile information on relevant monitoring protocols, tying them to specific management goals, and implementing and quantifying the cost of several different levels and methods. Although not all managers are rigorously monitoring or publicizing their treatment results, many to appear to be achieving considerable success in controlling invasive *Phragmites* in the Great Lakes region, at least for the short-term. We wanted to capture the knowledge and experience of managers who have been working with invasive *Phragmites* for a long time, to inform our compilation of practical monitoring protocols and to facilitate the telling of their story.

We convened a stakeholder meeting for practitioners to share their experiences with one another; to learn what management goals they have and how are they monitoring progress towards them; how they are prioritizing and sustaining invasive *Phragmites* management; what control methods they are using and the difficulties and/or successes they are having with them; what information gaps exist; and if they have novel approaches that aren't widely known or used. Discussions were focused on four key topic areas to help answer these questions: 1) measures of success and monitoring; 2) prioritizing management action and sustaining management over time; 3) control methods and unintended impacts; and 4) Pathways, re-invasion, secondary invasions and decontamination.

Methods

Invitations were sent to natural resource professionals who directly manage invasive *Phragmites* or work with others that do. Prior to the workshop, participants were assigned to one of four groups, each with representation from as many different agencies and organizations as possible. Each group was assigned to one of four stations corresponding to the four key topic areas noted

above. Facilitators and note-takers were selected from our project team for each topic area. They were primed with questions designed to assess the level of understanding and experience participants have with currently published control practices and how successful they are, and to draw out concerns, novel practices or other important considerations relating to each of the four topic areas. A note-taker was also selected to assist each facilitator and to capture key points from participant discussions.

Introductions were accomplished by asking participants to state their name, where they work and one word they think of when they are asked about *Phragmites* management. Participants were directed to their assigned group, each of which was assigned one of the four topic areas. A timer was set and facilitators led a discussion with their initial group for 27 minutes, after which, each group rotated to the next station. Discussions and rotations were repeated until all groups had participated in all four topic areas. After the rotations, each facilitator was asked to present a summary of the discussions for their topic area to the entire group, and entertain questions and discussion. Each participant was also asked to share one new thing that they learned or one thing that stood out to them as very important during the workshop. The workshop was concluded with an overview presentation of the Saginaw Bay project.

Sharing Insights on Invasive *Phragmites* Management
Agenda
Feb. 1, 2017
Michigan Tech Research Institute, Ann Arbor, Michigan

Meeting Goals:

- Gather practitioner knowledge that will improve planning, decision-making and implementation of strategic actions that address *Phragmites* invasions in Saginaw Bay
- Identify gaps in knowledge and resources
- Learn how to avoid unintended impacts from *Phragmites* management

Schedule:

(Rotation time)	9:00 – 9:15	Introductions and Instructions
(9:42)	9:15 – 9:45	Station 1: Measures of Success and Monitoring
(10:12)	9:45 – 10:15	Station 2: Prioritizing Management Action & Sustaining Management over Time
(10:27)	10:15 – 10:30	BREAK
(10:57)	10:30 – 11:00	Station 3: Control Methods and Unintended Impacts
(11:27)	11:00 – 11:30	Station 4: Pathways, Secondary invasions and Decontamination
(11:57)	11:30 – 12:00	Breakout Summaries, Discussion and Wrap Up
	12:00 – 1:00	LUNCH & Overview of Saginaw Bay Projects

Figure 1. Sharing Insights on Phragmites Management Meeting Agenda

Results

Participants: Thirty-two participants attended the workshop including wetland managers from Saginaw Bay and other regions of the Great Lakes, and representatives from USFWS, MDNR, MDEQ and USGS that are working on invasive *Phragmites* management (Table 1).

Table 1. Participant list grouped by initial topic. (Some shifts may have occurred due to late arrivals.)

Meeting Facilitator		
Phyllis Higman	Michigan Natural Features Inventory	Senior Conservation Scientist
Measures of Success and Monitoring		
Endres, Sarah (facilitator)	Michigan Tech Research Institute	Assistant Research Scientist
DaSilva, Abram (note-taker)	U.S. Geological Survey	Ecologist
Grout, Teri	U.P. Phragmites Coalition	Regional Project Manager
McFadden, Terry	MDNR-WD St. Claire Flats	Wildlife Biologist
Mindell, David	PlantWise, LCC	Owner
Schaefer, Emily	Saginaw Bay CISMA	Monitoring Team Leader
Smith, Brian	USDOT - Federal Highway Administration	Ecologist
Tangora, Sue	MDNR - Forest Resources Division	Forest Health and Cooperative Programs Section Manager
Prioritizing Management Action and Sustaining Management over Time		
VanderHaar, Michelle (facilitator)	USFWS – Shiawassee National Wildlife Area; Partners for Fish and Wildlife	Biologist
Putt, Doug (note-taker)	Wayne State Univ. (Prev. MDNR-WD)	Student
Bonello, Jake	Detroit International Wildlife Refuge	Lead Technician
Borneman, Dave	Parks & Recreation Services, City of Ann Arbor	Deputy Manager – Natural Areas Preservation (NAP)
Cohen, Josh	Michigan Natural Features Inventory	Lead Ecologist
Darling, John	MDNR-WD St. Claire Flats	Wildlife Technician
Majka, Brian	GEI Consultants of Michigan, P.C.	Environmental Consultant
Walters, Kevin	Michigan Dept. of Environmental Quality	Aquatic Biologist – Inv. Species
Control Methods and Unintended Impacts		
Bourgeau-Chavez, Laura	Michigan Tech Research Institute	Senior Research Scientist
Serocki, Nor	MACD-West by West CISMA	Stewardship
Clancy, Bob	MDNR-PRD-Stewardship	Ecological Restoration Specialist,
Dunton, Eric	U.S. Fish and Wildlife Service	Wildlife Biologist
Hahn, Michael	City of Ann Arbor	Stewardship specialist
Heise, Jeremiah	Michigan Department of Natural Resources	Wildlife Biologist
Howard, Shaun	The Nature Conservancy	Eastern Lake Michigan Project Coordinator
Nelson, Linda	US Army Corps of Engineers	Res. & Dev. Ctr, Environ. Lab
Pathways, Secondary Invasions and Decontamination		
Cronk, Kip (facilitator)	Michigan Sea Grant	Educator
Januska, Fallon (note-taker)	Saginaw Bay CISMA	Acting Coordinator
Bohn, Christine	Ozaukee Washington Land Trust	Project Coordinator
Cooley, Zach	MDNR – Point Mouille	Wildlife Biologist
Fahlsing, Ray	DNR-PRD	Stewardship Unit Manager

Pathways, Secondary Invasions and Decontamination (cont.)		
Januska, Fallon	Saginaw Bay CISMA	Coordinator
Jones, Tim	MDOT - Operations Field Services	Roadside Operations Specialist
Nelson, Danielle	Illinois Coastal Management Program	Associate Ecologist
Norwood, Greg,	USFWS Detroit International Wildlife Refuge	Wildlife Biologist (Currently- Inv. Spp. Coordinator, MDNR-WD

One Word about Invasive *Phragmites* Management

Twenty-five participants provided one-word that that reflected immediate thoughts about invasive Phragmites management. The remaining participants arrived late due to traffic slow-downs. The words are listed below categorized to show the relationship of their thoughts to the key topic areas selected for discussion during the meeting.

Success	**Prioritizing**	**Control**	**Control**	**Pathways**
Monitoring	Prioritize	Site-specificity	Persistent	Dispersal
Learn	When, when not	Standing water	Hot	Spread
Education	Where	Re-treat	Miserable	Decontamination
Cause		Post-treatment	Unknowns	Re-invasion
Symptom		Follow-up	Collateral damage	
Buy-in		After	Buy time	

Key Topic Areas

The notes for each of the key topic areas are presented below, along with a short summary and comments for each topic, provided by the Meeting facilitator. Different points of view were expressed for some items, and all views are reflected in the notes. Thus, contradictions in the notes reflect some level of uncertainty. The notes do not imply endorsement by the project team, rather they simply represent the different inputs provided by the meeting participants.

Measures of Success and Monitoring

Do managers have explicit goals and how are they determined?

- typically the goal is a reduction in invasive *Phragmites*
- several participants noted that they use a threshold value for measuring success, e.g., success is achieved when invasive *Phragmites* cover is less than 10%
- some sites are measured for success only if *Phragmites* is completely eradicated
- no specific comments recorded about how goals were determined

Do managers consider only decrease of *Phragmites* or also ecosystem impacts?

- most look primarily at a decrease of invasive *Phragmites*
- ecological factors are considered by some, depending on the project
- bird counts
- presence of other invasive species
- increase in plant diversity

What do managers think is important to measure?

- presence/absence, % cover reduction of invasive *Phragmites*
- invasive *Phragmites* reduction and biodiversity- what other species are present
- plant diversity/quality
- size and density of *Phragmites*, site quality, including ratio of non-native to native species, size of patch…

- acres treated
- holistic approach to site overall, some qualities are unmeasurable
- nutrient loading, water quality, other abiotic factors
- measures depend upon specific site conditions
- impacts at different scales

Are there important goals that are frequently not considered?

- scale and ultimate causes of invasion are rarely considered

How are managers monitoring?

- mostly conducting qualitative photo monitoring from outside the treatment area—rarely monitoring within the patch itself
- often times monitoring is just seeing if the site "looks better"
- quadrats for measuring % cover, stem densities of *Phragmites*
- point-line intercept with multiple transects to get relative frequency of all species present
- ideal to monitor every year but very funding dependent, and so is rarely happening
- should monitor before and after each treatment, but often, if it occurs at all, is done only post-treatment and for a year or two at most
- depends upon site specific site conditions, including ease of access

Is monitoring important and are we doing OK?

- important, but only 10% of budget reserved for monitoring by most grant sources
- typically very limited funding for monitoring, so much of it is anecdotal or photos
- need to involve landowners for long-term monitoring
- some managers are monitoring well

Do managers believe they are doing a good job controlling *Phragmites*?

- depends on where they are, site conditions, etc.
- better success in smaller sites
- better success in areas without standing water or without varying water levels
- sites with standing water or varying water levels are harder
- where water control exists, success is easier to achieve
- lake edges are difficult to access and treat successfully
- ability to access sites influences success
- follow-up treatments are needed, and if these can occur, more successful

- determination of success (monitoring) is completely funding dependent
- grant cycles are too short to take long-term monitoring into account
- some projects are managed by one group and monitored by another; hard to know level of success
- at least one manager indicated they are doing a really good job on monitoring and treatment success it good based upon reduction of invasive *Phragmites*
- doing a good job mapping, monitoring and treating, but not enough thinking about what comes after treatment
- if measure of success is nutrient uptake, then measuring this is not so good
- mistakes are often made, e.g., too intrusive, can kill non-target organisms, particularly with helicopter treatments
- wasteful spending could be reduced and success improved with better cooperation and collaboration among managers

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Summary

In general, managers are focused on measuring the reduction in invasive *Phragmites* cover and/or stem densities, with very little explicit mention of other goals. They recognize the value of assessing more than this, however, they don't often measure more parameters. Their measures of invasive *Phragmites* are often qualitative (estimates or photos) or sometimes anecdotal in nature, and based upon assessments from outside invasive *Phragmites* patches, rarely within patches. This is primarily due to the lack of funding, since many granting sources currently provide little funding or incentives for monitoring. There are some clear exceptions, where systematic quantitative monitoring is occurring. Typically, this monitoring focuses on invasive *Phragmites* cover or density, plant diversity measures or sometimes specific wildlife measures. Very little attention is paid to monitoring at different scales or identifying and mitigating ultimate causes of invasive *Phragmites* invasion.

Lack of quantitative monitoring does not mean that treatments are not successful, but it does mean that success cannot be easily quantified and shared. There remains, however, considerable uncertainty on the effectiveness of many control efforts, particularly at large sites, and over the long-term. For the most part currently published control practices are well known and utilized by managers, but are subject to site specific conditions as well as the experience of those doing the control. The conditions conducive to using imazapyr or imazapyr-glyphosate mix, vs glyphosate need to be better understood in order to tease out cause and effect. In addition, there is a lack of specific published monitoring protocols that address specific management goals. Those that do exist are often impractical to implement or may even pose safety concerns, especially when conducted in large, dense infestations in standing water.

Comments:

- While there is a lack of published protocols, in many cases, there also appears to be a lack of attention by some managers to specifying explicit management goals that would dictate the type and level of monitoring needed.
- Effective reduction of invasive *Phragmites* alone does not necessarily equal success. For example, if the goal is to restore a native wetland, and treatment results in a high

reduction of invasive *Phragmites*, but a low number of native plants returning, or the site is re-invaded or invaded by a secondary invader, in year 2, success has not been achieved. Success should be measured by how well the treatment of invasive *Phragmites* moves the project towards to specific management goals. Potential management goals are diverse and may include things other than restoring native flora and fauna, such as improving water availability, restoring aesthetic qualities, improving ecosystem function, establishing a no-vegetation zone, and others. Appropriate monitoring will vary depending upon specific goals.

- Measures of acres treated alone cannot be relied upon as a good measure of success. For example, treating 500 acres in invasive *Phragmites* with poor results is likely worse that treating 25 acres with high success. Or, preventing new invasions in pristine areas may achieve greater long-term success than trying to eradicate 500 acres in a highly invaded region. Additional measures provide a more complete story.
- A minimal monitoring strategy and ideally a tiered strategy, is needed so that managers can better quantify their success in order to justify continued funding to treat invasive *Phragmites,* as well as to improve management strategies.
- It is critical to communicate to funders the need for adequate monitoring funds in order to determine if treatments are successful or not and to inform and improve management. At least some funding should be provided for long-term and multi-scale monitoring as well as short term funding.
- It may not be practical or possible to achieve the level of monitoring desired with on-the-ground methods alone, particularly for large sites with dense invasive *Phragmites* stands. High statistical power typically requires high sample sizes, which is hugely time consuming in dense *Phragmites*. It is likely that combinations of on-ground monitoring with aerial imagery interpretation, including the use of drones will be a necessary part of the long-term solution to measuring success. Imagery and interpretation methods continue to improve and their use will help minimize treatment costs, by more precisely pinpointing where initial and follow-up treatment is needed.

Prioritizing Management Action And Sustaining Management Over Time

What factors are or should be considered when prioritizing management activities?

- Connectivity and potential for spread
- Outliers and leading edges
- Variability between locations
- Highest quality ecosystems / rare ecosystems
- Human activity / proximity to humans or housing
- Places where there is a need to show success (i.e., maybe most ecologically important)
- Seed viability / stand age
- Areas with appropriate and adequate man power and equipment

- Areas where treatment can be sustained
- Funding is not always directed at the most valuable systems, too much emphasis on new acreage
- Logistics and funding constraints often dictate where treatment actually occurs
- Managers are key to prioritizing their unique ecosystems / priority areas
- The MDEQ Phragmites prioritization tool provides valuable guidance; however, prioritization must be customizable – every manager's goals are too different

How can managers sustain treatment long-term?

- Stakeholder engagement
- Collaboration with outside partners
- Cultivate a positive public opinion / communication
- Monitoring that demonstrates success is can be a tool that supports continuing funding for management
- There is concern about whether existing projects can be sustained and successful after the addition of new projects
- Taking a watershed approach may be more efficient than a site based approach or in concert with a site based approach
- Early detection and responding to outliers and new infestations using a watershed approach is worthy of consideration, particularly in light of evidence that they may be more genetically diverse and therefore more competitive
- The word is getting out about reporting new infestations – MDARD was notified about a recent report of someone using *Phragmites* for roof thatching and followed up - it turned out to be *Phragmites* from Turkey and the seeds had been heat treated; point being that it was reported

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Summary

Managers are well aware of commonly suggested criteria for prioritizing treatment, however, no one size fits all. In addition, prioritization is often driven by logistical considerations and funding priorities, rather than strictly desired criteria. In spite of the best prioritization efforts, there is considerable concern about the ability to sustain treatments over time; there appears to be more emphasis on funding the treatment of new sites, rather than re-treating sites that have already been invested in. Finally, since consistent, multiple year monitoring is limited, it is not being used as effectively as it could be to inform priorities.

Comments

- It is important for managers to regularly step back and take stock of invasive *Phragmites* treatments in their areas of influence, to assess if they are truly optimal and to consider whether there better ways to achieve greater long-term success.
- Consider whether a rush to treatment due to immediate funding opportunities is always the best choice; perhaps better evaluation of the most impactful choices would produce better results in the long term.

- In order to better convince funders and critics of the wisdom of manager's priorities and effectiveness of treatments, monitoring must be implemented, analyzed, shared, and in some cases improved, to demonstrate successes and failures.

Control Methods And Unintended Impacts

Big Thoughts

- Logistics, not priorities or success may dictate how managers treat, based on when workers are available or how funding is dedicated
- Generally, fall glyphosate spray, post-treatment mowing or burning, and where possible flooding, is considered the BMP.
- Invasive *Phragmites* came in from somewhere, and chances are those sources still exist. Therefore, even if every stem in a given stand is gone, it will still need maintenance.
- Managers are willing and often able to switch to new methods if they are proven effective.

Herbicides:

Which herbicide?

- Use of glyphosate alone results in more regrowth of invasive *Phragmites* in the second year, but also more native plant regrowth and longer term restoration
  - after 3-4 years, no native species will return with imazapyr, and invasive *Phragmites* moves back in
- Use of imazapyr
  - only used in most areas as a mix with glyphosate; use was more prevalent before, but has been phased out by many managers
  - use in hand gun applications, rather than broadcast spraying
  - better for use over water, since the effects are more dilute
- Glyphosate vs imazapyr decision is partially based on water level
  - glyphosate alone over dry land, since imazapyr will create dead zones, due to activity in the soil for some years
- Use glyphosate for helicopter application
  - may have to move to imazapyr if invasive *Phragmites* becomes glyphosate tolerant
- Selection of herbicide is based on application method - minimize non-target impacts

Method of application

- For large stands, start with helicopter, move gradually to more and more specific yearly treatments; i.e., ATV, then backpacks, then hand application
  - continue indefinitely
- Hand swiping is applicable in sensitive areas

- Important to have nimble response to changes in composition; i.e., may need to hand swipe in one area, but be able to back pack spray 20 ft. away
- In areas that only need a little bit of maintenance each year, a spray bottle pointed straight down is perfect for single stems

Pre-herbicide cuts

- Plants should be "happy" before herbicide treatment, meaning early season mows may not be effective (i.e., need adequate leaf area to take up herbicide)
- Pre-herbicide mowing may limit the amount of herbicide that actually reaches the root to kill it – therefore may be less effective
- Pre-herbicide mechanical treatment isn't showing great results on a large scale, but may be good for land owners that want to retain views/shore use
    - may be good to make treatment more accessible, especially by backpack
- Mixed results with June cut and September spray, traditional post-treatment cut preferred
- Pretreatment cutting in June or July makes treatment easier
    - cut to ground, will grow to 3-4 ft. by treatment time
    - not very cost effective on big stands, but especially good for areas where tall *Phragmites* could be dangerous or undesirable
    - the plant is re-growing, meaning it is using more rhizome energy and could be moving more herbicide into the rhizome
- For private landowners, it is possible to keep invasive *Phragmites* cut to 1ft throughout the year and treat in the fall (does this mean it will be longer before total control is achieved
- The MDEQ Guide to the Control and Management of Invasive Phragmites recommends the following:
    - no pre-herbicide cutting should be done from March 1- July 15 to avoid impacts to nesting birds and animals
    - a minimum 4 weeks of growth is needed between cutting and treatment
    - ideally invasive *Phragmites* stems should be reduced to 4-12"
    - the mower deck height should be at least 4" to minimize impacts to small animals and native plants

Timing

- Spray when leaves are 50/50 yellow/green
- Some areas have October 1st cut off for treatment due to hunting and recreation use
- Some have treated with success post-snow
- September 10th is the "target date" in SE Michigan, with 90% of treatment in the month of September

- Doing multiple, "smaller" treatments throughout the year may lead to a smaller total amount of herbicide while increasing coverage
    - but large increase in labor costs

Mechanical Treatment

- Mowing/burning without herbicide only provides a temporary visual improvement, but not long-term control
- Post-herbicide mowing may improve access for the next year and make winter burns safer
- Removing thatch doesn't kill the plant, but makes follow up treatments easier and cheaper; may also allow faster regeneration of native plants
- Biomass removal is best, when achievable, but is dependent on logistics and funding
    - burning is first choice
    - crushing is second choice
- Mow after herbicide treatment to remove biomass, then treat any regrowth the next year
- Ice shear can do the same job as mechanical treatment in some coastal areas
- Removing biomass can result in greater wave action - likely minimizes frog-bit invasion
- A Truxor DM5000 tracked vehicle imported from Europe is being deployed by small crews in shorelines along Lake Huron and Georgian Bay; cuts *Phragmites* below waterline, deprives it of oxygen; important because use of herbicide is prohibited in or near water in Ontario
- See also comments on "pre-herbicides cuts" above

Prescribed Burning

- Generally burns are conducted in the dormant season, but this may be due to availability of fire crews
- Because of the way *Phragmites* burns, it can be very dangerous; precautions and expertise are needed
- Knocking *Phragmites* flat before burning makes burns safer; can reduce burns to < 5 ft.
- Fire cannot carry as well without leaves, making it hard to burn stands that are just the standing stems
- Burning is very limited by roads, homes, etc.
- The MDEQ Guide to the Control and Management of Invasive Phragmites recommends:
    - late summer burns: mid-July through August, depending upon herbicide;
        - preferred time-frame: kills seed heads, removed dead stems, likely to kill remaining live *Phragmites* stems, allows green-up of native plants before first frost
        - must consider impacts to nesting birds, amphibians and reptiles
    - if summer burns not feasible, then winter burns: January to just before green-up

- prepares site for subsequent herbicide application - easier to locate live *Phragmites* sprouts, removes dead stems, exposes native seeds to sunlight

Water level manipulation

- Lowering water levels can lead to *Phragmites* invasion in areas that may have been too deep before hand
  - a few areas have lowered water levels because white water lily (*Nymphaea odorata*) made them impassable; these areas had been *Phragmites* free for > 30 years, but invasive *Phragmites* quickly started growing when water levels rose
- Flooding after herbicide and mowing results in very little regeneration of *Phragmites*
  - treat any remaining live *Phragmites* next year over water
  - may not be "better" than not flooding but it stops *Phragmites* from becoming worse
  - 18" of water is general rule of thumb
- Chris May working with flooding in Erie marsh
  - early season flooding with late season draw down
- The MDEQ Guide to the Control and Management of invasive *Phragmites* indicates:
  - increasing water levels alone will not control invasive *Phragmites*
  - early drawdowns may encourage invasive *Phragmites* growth
  - drawdowns should be in late summer to maintain and promote native vegetation and avoid re-establishment of invasive *Phragmites*

Revegetation and Restoration

- Native species seed and rhizome banks are more adapted to flooding than non-native
  - after draw down, native regrowth can be very high
- Native species rhizome bank can be 80% of regrowth in opened areas
- The MDEQ Guide to the Control and Management of Invasive Phragmites indicates:
  - seeding after invasive *Phragmites* control is not typically necessary since native seeds are normally present in the soil; recommends letting revegetation occur naturally unless monitoring reveals lack of seed bank

Technology

- Using UAVs/drones for treatment and tracking
  - autonomous drone to sense and treat individual stems
  - may have issues with using UAVs on government property
  - flying to recognize areas of native *Phragmites*/remnants to avoid treatment
  - flying post-treatment to identify live invasive *Phragmites* stems for retreatment
- Agriculture uses sensors on boom arms to ID and selectively treat plants out of rows or weeds

- apply this technology to a marsh master to treat re-sprouts of invasive *Phragmites* quicker, with less herbicide

Funding

- Lack of funding for research while instead funding "traditional" treatments means we have no BMPs and no "one" answer
  - Methods used haven't changed in 20 yrs. and need updating

Questions

- Some landowners are willing/wanting to remove seed heads by hand before herbicide treatment. Is this "worth it"? Is there any way this could go wrong?
  - If there is a volunteer force willing to, there is no reason not to
  - May be most "worthwhile" in young stands with most viable seeds
- Some groups are using growing season burns (roughly August) rather than winter burns. Is this successful? What difference does this make?
- Is there any data available on the total amount of herbicide used based on the type of treatment and the application method?
  - i.e., if we backpack spray using Imazapyr, will we use less total herbicide on the same area than if we treated aerially with Glyphosate?
- How can we set up controls in experiments, given that allowing populations to remain is a seed source and degrades the area?
- When doing multiple treatments in one year, how do you know when to time the rounds of treatment?
- Does going back post-treatment for the small sprouts actually do damage to the root?
- Is there a difference between seed and rhizome sprouts? Can we determine the source of a sprouting *Phragmites* stem?
- How applicable is stem injection for small areas, very sensitive ecosystems, and homeowners?
- Where are biocontrols?
  - endophytes to interrupt root networks (USGS) are being studied
  - moths under research, but may have "stalled out"
  - grazing difficult in wetlands with erosion, also *Phragmites* is the last thing most grazers eat
- Is it safe to move mowed *Phragmites* or biomass? Can this create spread issues?
- How do we remove small post treatment "waiting populations?
  - In the Grand Traverse region, only herbicide has been used; remaining patches are only a handful of stunted stems that don't appear to translocate the herbicide. How can we remove these stems that are "waiting" for us to stop managing?

Worries, Concerns and Unintended Consequences

- We have very little information on the faunal use of native *Phragmites* vs non-native *Phragmites* or the flora typically associated with native *Phragmites*
    - native *Phragmites* often grows with invasive *Phragmites* and on its own can reach similar densities as invasive *Phragmites* in high nutrient areas
- Imazapyr has much harsher and longer term non- target impacts
    - this is minimized when used over water
- Imazapyr leads to low restoration and soil loss
    - seed bank of native plants has very high die off
    - invasive *Phragmites* returns 2-3 years later because nothing else has "filled the space"
    - Saginaw Bay area had an area with standing water that had much better restoration with imazapyr use, possibly because of dilution and lack of soil storage
- Proposed new spring treatments pose a risk to nesting birds
    - possibly only an issue at edges and in newer (less dense) stands
- Nitrogen addition from continued herbicide use isn't considered
    - How are we augmenting soil nitrogen?
    - With native and non-native *Phragmites* doing better in high nitrogen areas, what issues is this creating?
    - Could become significant with endless application of management applications
- Augmenting water levels can negatively augment fish movement
- Are we creating herbicide resistance?
- How sustainable is it to have to follow up indefinitely?
- There is a lot of missing information on native *Phragmites* and how often we are treating this this instead of the invasive.

Summary

Most managers are implementing accepted, published control practices, varying the herbicide used and method of application according to site specific conditions. Generally aerial spraying is used on large sites, then ATV, then backpacks sprayers and then hand application, as sites or retreatment areas get smaller in size. There is widespread agreement that long-term maintenance will always be needed, with best case scenarios of 3-4 years before re-treatment is required.

It appears that the use of imazapyr alone has declined due to negative impacts on native plant emergence on land; manager experiences have been mixed, which has resulted in a fair amount of uncertainty. The cause and effect of "dead zones" when imazapyr, has been used, needs further study and clarification to determine whether it is due to the chemical or site conditions (water vs soil) or something else entirely. Better guidance on appropriate use of imazapyr and

mixes of imazapyr and glyphosate is needed in order to ensure that native seed banks are utilized to the fullest extent possible to compete with *Phragmites* re-invasion.

Removal of thatch by prescribed burns is considered optimal but in many instances it not feasible due to logistical constraints and weather patterns. Mowing and then crushing are second and third choices, however many managers are hampered by lack of proper equipment and man-power as well as weather conditions. Where water level manipulation is possible there can be good results, but draw-downs too early in the season, can result in *Phragmites* invasion or resurgence. Seeding in native species on treated sites has not typically been necessary or recommended; however, it is being utilized in some restorations where native regrowth is limited.

There is considerable debate about the value of early pre-herbicide cuts with some strong proponents of this technique and others stating that it doesn't show good results. Most agree that it can be useful in some cases, e.g., when the height and density if invasive *Phragmites* makes herbicide treatment unsafe or where the management goal is to maintain good views. If pre-herbicide cutting is used, it is important to consider impacts to nesting birds and other animals, as well as the total amount of herbicide applied to ensure regulatory compliance. Further study of this method is warranted to better quantify achievable results and should include consideration of site specific conditions and local weather variables.

Relatively new on the horizon, in addition to pre-herbicide cuts, is the practice of multiple herbicide treatment in one season, the use of amphibious vehicles to cut Phragmites below the waterline where herbicides are not permitted, and drone technology to capture pre and post-treatment conditions. Optimal uses of these techniques and tools will no doubt be determined in the coming years. In addition, research on biocontrols is ongoing, including disruption of root endophytes, identifying selective herbivores that eat various parts of invasive *Phragmites*, gene silencing and grazing.

Concerns were expressed about potential impacts to native *Phragmites* during treatments as well as the potential consequences of native *Phragmites* becoming aggressive in high nutrient areas; severe long-term impacts with the use of imazapyr in some settings; risks to native birds with pre-herbicide cutting; how to address ultimate causes of invasion, such as nutrient inputs; the impact of water level manipulation on fish movements; and potential herbicide resistance. These all need to be addressed.

A number of specific questions relating to control methods were also put on the table. These centered around the advisability of seed head removal; risk of moving mowed biomass; risk of summer burns; comparisons of the amount of herbicide used by different application methods; timing of multiple year treatments; how to set up controls without risking of them being sources for re-invasion; applicability of stem injections; and how to make the final kill with small, sometimes stunted seed and rhizome sprouts.

Comments

- Implementation of consistent monitoring is needed to accumulate evidence that will address the uncertainties in management techniques and to demonstrate that true value of funding invasive *Phragmites* control.
- Research studies to clarify the impacts of and appropriate uses of imazapyr and assess the efficacy and risks of pre-herbicide cutting are needed
- Resources are needed to fully equip managers with the tools needed for most effective control practices.
- More opportunities are needed for managers to consider large landscapes together to reflect and fine-tune management decisions.
- We will provide responses, if known, to specific questions in a follow-up communication to meeting participants.

Pathways, Re-Invasion, Secondary Invasion And Decontamination

What other invaders are managers observing invading in after *Phragmites* treatment?

- non-native cat-tails (*Typha angustifolia*, *Typha* x*glau*ca)
- European frog-bit (*Hydrocharis morsus-ranae*)
- non-native thistles (*Cirsium arvense, Cirsium vulgare, Cirsium palustre*)
- purple loosestrife (*Lythrum salicaria*)
- yellow iris (*Iris pseudacorus*)
- flowering rush (*Butomus umbellatus*)
- glossy buckthorn (*Frangula alnus*)
- Japanese knotweed (*Fallopia japonica*)
- Teasels (*Dipsacus laciniatus, Dipsacus fullonum*)
- reed canary grass (*Phalaris arundinacea*)
- barnyard grass (*Echnochloa crusgalli*)
- annual weeds (*Bidens* spp.)
- Fireweed (*Erechtites hieraciifolius*)

Are managers prepared to treat these new invaders?

- historically no
- now yes, many are anticipated/expected and dealt with
    - however, there are problem weeds such as reed canary grass
- some monitor the secondary invaders, but do not have the manpower to treat them
- some people are moving away from just treating, and having re-vegetation as a plan
    - re-vegetation for stream bank stabilization
    - site based approach
- some manage for thresholds (e.g. < 10% cover) = never abandon an area
- some are identifying areas where seed bank will manage itself
    - supplementing the seed bank happens
- currently most do not try and manage cat-tails
    - some only manage cat-tails where there is a threatened plant present

    - there was a comment in the wrap-up where someone indicated that mammal diversity was affected by non-native cat-tails

Do certain management practices facilitate invasions? If so, how can this be addressed?

- follow treatment with burning
    - burning reduces biomass and opens area to wave action and prevents frog-bit establishment
    - does leaving the biomass leave stuff for native vegetation to regrow and stop opportunistic invaders?
- Lack of management plans with private landowners
    - education to landowners that the next thing might not be good either

Are there specific herbicides or other treatment methods that result more frequently in secondary invasions? Why?

- imperfect because their aren't really that many choices
- most people use glyphosate
    - will invasive *Phragmites* build up a resistance to glyphosate?
- imazapyr facilitates more secondary invaders because it kills everything
    - some started using imazapyr when glyphosate didn't work
    - some only use it in monocultures of invasive *Phragmites*
- does long-term effects of imazapry affect the seed bank?
- results depend on conditions
    - was it the herbicide or the site?
    - lake levels
    - water breaks down chemicals more/dilutes it and carries it away

Are managers following decontamination procedures and principles?

- for some it is up to the contractor
- for some decontamination is in the contract with the contractor
    - some contracts state they MUST clean equipment before entering a site, when moving around, but not when leaving a site
    - some contracts have cleaning before and after sites
    - most do not check to make sure the contractor is decontaminating
- personal decontamination is recommended to managers between sites
    - crew supervisors should be making sure that happens

Why or why not? What are they doing specifically?

- some protocols state the level to which things need to be cleaned, but not how to clean to achieve that level
- it can take up to 12 hours to clean a marsh-master
    - decide when the investment should be made based on quality of site moving to
- generally people are more likely to make sure everything is clean when they know they are headed to a high quality site
    - not too worried when going from one *Phragmites* site to another
- some equipment hardly ever leaves a specific site, so they do not clean it

- State Game Areas worry about hunters spreading invasive *Phragmties*
    - education is out there, but it is hard to police
    - losing battle due to bass/duck tournaments

Do managers have the resources to decontamination well?

- most have the means and the knowledge
- some have power washers at the shop, so they wait to fully decontaminate there
- employees are given boot brushes
- some have boot brushes on the trailer hitch

What are other invasive *Phragmites* pathways?

- hunters
- some move it for deer habitat
- some use it to brush their blinds
- boaters
- wind
- water
- people
- construction equipment

Summary

Invasive *Phragmites* control frequently results in conditions ripe for secondary invasions and managers are increasingly more prepared for them than in the past. However, sometimes they lack the staff and funding to deal with them and there are some species that come in that are very difficult to effectively control, such as reed canary grass. In addition, they are just beginning to deal with some newer species, such as European frog-bit, and are still learning what the best control methods are. Other species, such as non-native cat-tails, that have long been considered somewhat benign, are showing increasing evidence of negative impacts to ecosystems and wildlife after invasive *Phragmites* removal.

Where imazapyr is used over land, many managers have observed dead zones that inhibit native plants from re-establishing; this leaves the site vulnerable to re-invasion by invasive *Phragmites* when the effects of imazapyr in the soil finally wear off.

Regeneration of native species is good in many places; however, some managers are including revegetation after treatment, e.g., in streambank restorations and some site-based restorations

Managers are generally well versed in the need for decontamination, however actual decontamination is variable. This is in part, due to specifics of contracts and the time and expense to carry them out, but sometimes due to lack of information about specific decontamination procedures. Managers generally appear to be more concerned and careful when going to high quality sites and less so when going from one invaded site to another. Managers are concerned about other vectors, especially hunters, some of whom use *Phragmites* in blind construction and for deer habitat.

Comments

- It is a good practice to scout for potential secondary invaders at every treatment site and be prepared for them and design your treatment accordingly.

- While it may take time and money to decontaminate, it takes more money to treat new invasions, and it is a waste of money to treat a site that was re-infested by vectors that could have been prevented. Vigilance about not spreading propagules is imperative and teaching others is important.
- Targeted messaging to hunters seems important; it is illegal to transport invasive *Phragmites*.
- Better understanding of the effects of imazapyr on treated sites is needed in order to minimize its influence as a factor in facilitating secondary invasions.

One thing learned or most important take-home from today

Big Thoughts

- We are in a good place in Michigan
- Funding is a concern on many fronts
- Complexity of it all
- I am not alone, lots of uncertainty

Measure of Success and Monitoring

- Framework shift – what's best for the environment, community buy-in
- Redefining success
- Different measures of success
- Monitoring to track better indicators than acres treated
- Move from acres treated to other parameters
- Intensive monitoring
- Follow-up monitoring
- Language in grants is too narrow
- Phragmites is a symptom of other problems, e.g., nutrient inputs; should reducing this be a measure of success?

Prioritizing and sustainability

- To sustain management
- Sustainability
- Prioritization should expand to take into account the necessary logistics
- MISGP focuses only on early detection species, but needs to allow for secondary invasions that are not target species for the grant.
- Seed viability in outliers higher
- Seed viability varies by stand age – evidence for higher genetic diversity in outliers

Control Methods and Unintended Consequences

- No one way
- Different methods
- Variations
- Commonality and differences
- Open water control contact
- Presence of water buffers impact of imazapyr
- Imazapyr impacts seems to vary with water level
- Imazapyr and seed banks
- More research on biocontrol
- Been treating invasive *Phragmites* the same way since I was 18 years old and little has changed; this problem has not been elevated in importance, like research on drugs, for example (editorial; it has been elevated in the sense that tons of money goes to treating it, but less to the needed research)

Pathways, Re-invasion, Secondary Invasion and Decontamination

- Decontamination is still an idea for many - not implemented yet
- Secondary invasions are problematic, e.g., non-native cat-tail appears to be affecting mammal use; don't know how to treat incoming reed canary grass
- A preview of site conditions, would allow the prediction of secondary invasions and therefore the ability to cost them into treatment plans

New Tools:

- ArcCollector
- Ecological economist
- Drone pre- and post-monitoring
- Drone detection and auto treatment of Phragmites like agricultural weeds

Other Miscellaneous Comments and Thoughts

- We need to move beyond *Phragmites* control, to serious site restoration; i.e., specifying management goals and addressing all aspects of restoration, only one of which is invasive *Phragmites*.

- This participant group was somewhat biased towards groups with access to good funding sources and equipment, etc.; landowners were not represented well, but need to be a big part of the solution.

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Table 1. List of Participants – *Phragmites* Management Stakeholder Meeting held on Feb. 1, MTRI, Ann Arbor, MI

Participant	Affiliation	Title
Danielle Nelson	Coastal Management Program, Illinois DNR	Associate Ecologist
Christine Bohn	Ozaukee Washington Land Trust	Project Coordinator
Kevin Walters	Michigan DEQ	Aquatic Biologist - Invasive Species
Laura Bourgeau-Chavez	MTRI	Senior Research Scientist
Abram DaSilva	USGS	Ecologist
Brian Smith	USDOT - Federal Highway Administration	Ecologist
Darcy Rutkowski	U.P. Phragmites Coalition (UP RC&D Council)	Project Manager/Executive Director
Teri Grout	U.P. Phragmites Coalition (UP RC&D Council)	Regional Project Manager
Eric Dunton	USFWS	Wildlife Biologist
Brock Woods	Univ. of Wisc. Extension/WDNR	WI Wetland Invasive Plant Program Coordinator
Michelle VanderHaar	USFWS	
Kip Cronk	Michigan Sea Grant	

Participant	Affiliation	Title
Laura Ogar	Environmental Affairs and Community Development	Bay County Director
Ray Fahlsing	Michigan DNR-PRD	Stewardship Unit Manager
David Mindell	PlantWise, LCC	Owner
Sarah Endres	MTRI	
Brian Majka	GEI Consultants of Michigan, P.C.	Environmental Consultant
Jeremiah Heise	Michigan DNR	Wildlife Biologist
Shaun Howard	The Nature Conservancy	
Doug Putt	Wayne State Univ. (Prev. strike team MDNR-WD)	Student
Bob Clancy	Michigan DNR-PRD-Stewardship	Ecological Restoration Specialist,
Dave Borneman	Parks & Recreation Services, City of Ann Arbor	Deputy Manager – Natural Areas Preservation (NAP)
Tom Braun	Former MDNR-WD strike team	
Linda Nelson	US Army Corps of Engineers Eng. Res. & Dev. Ctr, Environmental Laboratory	
Jesse Lincoln	Michigan Natural Features Inventory	Associate Ecologist
Phyllis Higman	Michigan Natural Features Inventory	Sr. Conservation Scientist
Fallon Januska	Saginaw Bay CISMA	Acting Coordinator
Josh Cohen	Michigan Natural Features Inventory	Lead Ecologist
Tim Jones	MDOT - Operations Field Services	Roadside Operations Specialist